

## **5.0 Development of Travel Demand Model**

Developing the travel demand model for the portions of Columbia County currently not included in the ARTS model was an integral part of developing the LRTP. The model was used to develop future year traffic forecasts, test various alternative networks and aid in the implementation of the LRTP. The Columbia Model has the following main modules:

- Highway Network Module
- Trip Generation Module
- Trip Distribution Module
- Traffic Assignment Module

Descriptions of each module are presented in the Model Technical Memorandum (dated March, 2004). A brief summary can be found in the following sections.

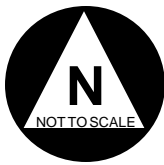
### **5.1 Highway Network Setup**

In addition to the existing model network, the highway network for the Columbia Model relied on the street centerline file provided by the Columbia County Planning and Development Services Division. The network was reviewed and approved by GDOT. All roads with GDOT traffic count stations were included in the Columbia Model highway network.

Link attributes, such as functional class and number of lanes, were obtained from the functional class system map and Road Characteristics (RC) file, both maintained by GDOT. Functional class is fundamental in the determination of other attributes, such as speed and capacity. Using the future land use map, seven area types are identified and coded as follows:

- High Density Urban
- High Density Urban Commercial
- Urban Residential
- Suburban Commercial
- Suburban Residential
- Exurban
- Rural

A graphical representation of the model highway network is presented on Figure 5.1.



Lincoln  
County

South  
Carolina

McDuffie  
County

Columbia  
County

Augusta

Harlem

Grovetown

Richmond  
County

**Legend**  
Road Links  
Centroid Connector

## 5.2 Trip Generation Module

Trip generation is the first step in the Columbia County travel demand modeling process. This process is accomplished by establishing relationships between trips and socioeconomic variables. The number of trips that begin and end in each traffic analysis zone (TAZ) are estimated using cross-classification tables and/or regression methods. Cross classification tables used in the trip generation process were obtained from the Trip Generation Update Project. This project was conducted by the Georgia Department of Transportation (GDOT) in 1997, and included a household travel survey and external travel survey in the Augusta metropolitan area, including Columbia County.

Typically, three types of trips are included in travel demand model: (1) internal-internal (I-I) trips whose origin and destination are inside the study area boundary; (2) internal-external (I-E) trips that have exactly one trip end inside the study area; and (3) external-external (E-E) trips that have both trip ends outside of the study area. I-I trips follow the production and attraction logic of trip formulation, and are commonly grouped into several trip purposes. I-E and E-E trips are developed separately using a different methodology that is heavily dependent on traffic counts observed on the principal roads leading into and out of the region.

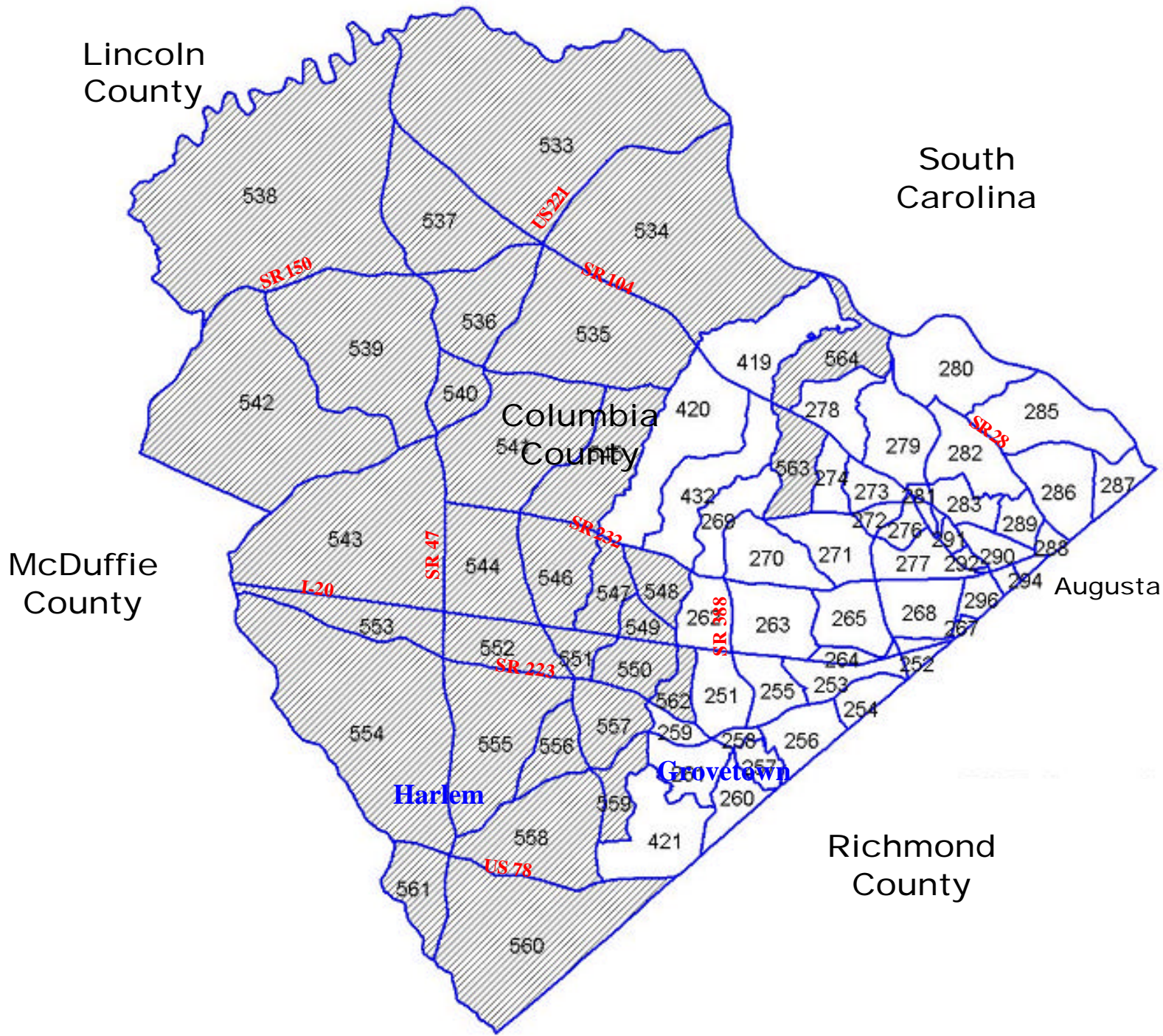
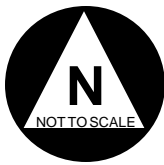
Seven trip purposes, as adopted by GDOT, were included in the trip generation process. These purposes are summarized below:

- **Home Based Work (HBW)**: all travel made for the purpose of work that begins or ends at the traveler's home.
- **Home Based Shopping (HBS)**: trips made for the purpose of shopping that begins or ends at the traveler's home.
- **Home Based Other (HBO)**: any trip made with one end at the home except those for the purpose of work or shopping.
- **Non-Home Based (NHB)**: any trip that neither begins or ends at home.
- **Internal-Internal Truck (IIT)**: internal trips made by commercial vehicles.
- **Internal-External Car (IEC)**: internal trips that begin or end outside the model area, excluding trucks.
- **Internal-External Truck (IET)**: internal truck trips that begin or end outside the model area.

Per guidance provided by the GDOT and Columbia County staff, eighty-two (82) traffic analysis zones (TAZs) were included in the Columbia County travel demand model. The TAZ boundaries were determined using existing TAZs and using GDOT functionally classified roads for TAZ boundaries. Census data was also considered. Several TAZ's in the southeast part of Columbia County were included in the ARTS model and their integrity was maintained for the Columbia County Model. The TAZ boundary map is illustrated in Figure 5.2.

Socioeconomic data for all TAZs was developed by the Columbia County staff based on the 2000 census data. For each TAZ in the Columbia Model, the following socioeconomic variables, standard to transportation modeling, were collected for use in the trip generation process:

- **Occupied Households** : the total number of occupied households in a given TAZ.
- **School Enrollment**: the total number of enrolled students in a given TAZ where the educational facility is located.
- **Retail Employment**: number of employees working for retail businesses in a given TAZ where the business is located.
- **Service Employment**: number of employees working for service based businesses in a given TAZ where the business is located.
- **Manufacture Employment**: number of employees working for manufacture based businesses in a given TAZ where the business is located.
- **Wholesale Employment**: number of employees working for wholesale-based businesses in a given TAZ where the business is located.
- **Total Employment**: the total number of individuals that are working in a given TAZ.
- **Total Population**: the total number of individuals that are residing in a given TAZ.
- **Acreage**: area of a given TAZ in acres.
- **Income** : median household income in a given TAZ in year 2000 dollars.



**Legend**  
Original TAZ  
New TAZ

### 5.3 Trip Distribution Model

The trip distribution module allocates trips generated in one zone to all other zones in the study area. A gravity model is used by the Columbia Model to perform trip distribution. The Gravity Model states that the number of trips between two zones is directly proportional to the number of trip attractions generated by the zone of destination and inversely proportional to a function of travel time between the two zones. Mathematically, the gravity model is expressed as follows:

$$T_{ij} = P_i \left[ \frac{A_j F_{ij}}{\sum_j A_j F_{ij}} \right]$$

where,

- $T_{ij}$  = number of trips that are produced in zone i and attracted to zone j;
- $P_i$  = total number of trips produced in zone i;
- $A_j$  = number of trips attracted to zone j; and
- $F_{ij}$  = friction factor, a value which is an inverse function of travel time.

The input for the gravity model consists of the productions and attractions from trip generation and a set of travel time impedance factors (friction factors). The friction factors are inversely related to the spatial separation of zones. As the travel time increases, the friction factor decreases. The friction factors developed for the ARTS model were applied to Columbia Model.

### 5.4 Mode Split

Mode split is the determination of what mode of travel will be used to make trips between zones. The FHWA manual *Calibration and Adjustment of Systems Planning Models (FHWA-ED-90-015)*, acknowledges that in small or medium urban areas, transit patronage may be too insignificant to warrant an adjustment to highway volumes for transit trips. Since the transit portion of the trips in Columbia County is significantly smaller than the +/- 5% margin of error for the model calibration, the mode split step is eliminated from the Columbia Model.

Since the Columbia Model assumes that the automobile is the only mode, the full mode split process is simplified into a factoring calculation to convert person trips to vehicle trips. Occupancy rate was introduced to account for the ridesharing. Since I-E and E-E trips were calculated in terms of vehicle trips at their inception, no adjustments were made for these purposes.

## **5.5 Traffic Assignment**

The last step in the modeling sequence is the assignment of the trip tables to logical routes in the highway network. Trip assignment for the Columbia Model was accomplished using the equilibrium assignment technique. The traffic assignment algorithm is iterative, running through successive iterations until equilibrium occurs. Equilibrium occurs when no trip can be made on an alternate path without increasing the total travel time of all trips on the network.

The following steps were included in the traffic assignment process:

- Convert daily trips to AM, PM and off-peak trips;
- Apply Volume-Delay functions to calculate peak and off-peak travel time;
- Distribute the work trips using congested travel times, and distribute non-work trips using off-peak travel times estimated from the preliminary trip assignment process; and,
- Assign AM, PM and off-peak trips to the highway network following the peak path.